## LETTER FROM E. KOPKE.

Honolulu, December, 1894.

Mr. B. F. Dillingham,
*General Manager O. R. & L. Co.*,
Honolulu.

Dear Sir:—At your request I have carefully looked into the problem of irrigating the lands of the proposed Oahu Sugar Company situated in Ewa district, Oahu.

For this purpose I have made myself acquainted with the different points of interest on the lands and have before me a survey, given to me by Mr. C. H. Kluegel, showing the areas under different levels and other important matters.

In my calculation of pumping expenses I have taken figures from actual experience and have been careful to allow liberal margins everywhere. In determining the amount of water required per acre I have taken for my basis 25 per cent. more than is used on Ewa plantation, and have counted on 250 days irrigating per year, whereas 200 days is more than on an average irrigation will be carried on, especially as these lands have the benefit of showers of rain which do not reach the lower lands.

### WATER SUPPLY.

(*a*) Springs. There is a stream at the lower part of these lands which obtains its water from springs, which was measured by Messrs. Allardt and Schuyler, both engineers of high standing, and found to flow over 42 cubic feet of water per second; this amount of water will irrigate 3300 acres of cane land. This amount of water can undoubtedly be increased, as some of the springs supplying the stream discharge their water several feet about the bottom of the creek, and by lowering their place of discharge the amount of water will be increased. How much this increase will be can only be found by trial and cannot enter into this calculation.

(*b*) Artesian wells. All artesian wells which have been bored in this district have shown a wonderful supply of water. There are 12 ten-inch wells on Ewa plantation, all in a space of 150 feet by 100 feet, which deliver constantly through the driest part of the year fifteen million gallons per day without showing any diminution in the supply. About one-third of a mile from this station there is another one with six wells which delivers seven and a half million gallons with the same results; all these wells are to the west of the proposed "Oahu Sugar Company." To the east there are the wells in Pearl City and the peninsula which give an abundance of water. I am not able to give the capacity of either of these wells, but none of them have been exhausted by pumping.

There is no reason to believe that wells on this proposed plantation will not do just as well as the ones mentioned above. One or two wells dug at the very place, where a proposed pumping station is to be placed, would certainly expel all doubt, if there is any, in regard to the water supply by artesian wells.

### RESERVOIRS.

There seems to be a good chance of storing storm water in reservoirs. The water might be led out of the gulches by ditches or flumes and stored in reservoirs situated above the cane fields. As this is a problem for a civil engineer to solve, I shall not enter into it any further.

### PUMPING MACHINERY.

The amount of water and the height it has to be lifted, being considerable, it becomes absolutely necessary that only very large steam pumps of the most approved designs and construction be used in order to obtain a very high degree of economy. With the different types of pumps on these islands used for the purpose of irrigating cane land, different degrees of efficiency are obtained. Having the data of the more important of these machines, very valuable points may be obtained for purchasing and erecting a new plant of this nature.

### COST OF IRRIGATION PER ACRE.

In starting the plantation the lower lands, say under 300 feet elevation, will be planted first, and as more land will have to be taken in, the adjacent lands above will come under cultivation up to 650 feet above sea level. This elevation takes in an area of over 10,000 acres as shown in map before mentioned.

It is evident that the lower lands will cost less for irrigation than the upper ones, and therefore irrigation expenses for the first years will be less than afterwards, when the higher lands have been taken up. I cannot at this moment determine how land under different elevations will come under cultivation and shall therefore take the average height of all the lands under 650 feet elevation and base on this the calculation of expenses. The average height is obtained by multiplying the different areas by their respective heights, adding these products together and dividing the sum of these products by the total number of acres, which gives an average height above sea level of 440 feet; deduct from this the artesian water level, 30 feet, leaves 410 feet.

As it is proposed to plant 2000 acres per year, I have figured on a pumping plant of this capacity and get the following:

| | | |
|---|---|---|
| Coal per acre per year, 6.07 tons at $7.50 | | $45 50 |
| Superintendent per year per 2000 acres | $ 2,000 00 | |
| Two assistants " " " | 2,400 00 | |
| Two oilers and four firemen per year per 2000 acres | 1,800 00 | |
| Oil, waste, packing per year per 2000 acres | 3,000 00 | |
| Incidentals per year per 2000 acres | 1,800 00 | |
| Per year per 1 acre | | $ 5 50 |
| Total | | $51 00 |

In the above figures you will see that I have allowed a liberal amount for wages, those of superintendents will decrease if stations for more than 2000 acres are erected, as one superintendent can look after two stations easily.

The actual horse-power to lift the water for 2000 acres, 410 feet high, is 1470, I have taken 1500, and allowed three pounds coal per horse-power per hour.

In submitting this report to you, I feel confident that the actual consumption of coal will be from twenty to twenty-five per cent. less than given here, if the right kind of machinery is used.

I am, yours very respectfully,
E. Kopke, M. E.

## ANALYSIS OF SOILS.

By Prof. A. B. Lyons.

Honolulu, H. I., Nov. 12, 1894.

Result of analysis of samples of soils taken from land in Ewa (locations indicated on the map).

The lands in question lie on the lower slopes of the Waianae and Koolau mountains, extending from 100 to 650 feet above sea level. In nearly the whole of the region, the soil consists of fully decomposed volcanic rock, containing no stones and but little gravel or sand. The soil is generally deep, and although it is distinctly clayey, it is easily pulverized. Containing much iron, it has nearly everywhere a deep red color, and consists mostly of a powder of impalpable fineness. At the lower levels there are small areas of gray-brown soil, represented in the accompanying tables in No. 4, the character of which is quite different from that of the red soils. It seems to be of more recent origin, probably formed from material ejected in the later volcanic eruptions, and so still containing fragments of undecomposed lava, and a notable proportion of unoxidized iron.

The mechanical analysis of the soils shows a great preponderance of finely divided material, from which plants ought to be able, easily, to take out the mineral elements they require, provided these are present. Less than fifteen per cent. of the soil in the samples analysed consists of particles more than one two-thousandths of an inch in diameter.

Number one is a distinctly clayey soil, yet even this one appears to be quite easily tillable. In number two, however, the proportions of clay and sand seem more favorable, not only for easy tillage but for the absorbtion and retention of water from rain.

The chemical analysis shows that the soils are not deficient in any of the constituents on which fertility depends. The proportion of lime is rather small, as it is in most Hawaiian soils, but it is probably sufficient for every demand that agriculture might make. The soils are not deficient in potash, and contain a good proportion of phosphoric acid and of combined nitrogen.

As far as chemical analysis shows, they rank as rich soils. As in the case of other Hawaiian soils, it is probable that a judicious application of phosphate and nitrated fertilizers will even from the first prove remunerative, since these supply plant food already digested, as it were, the constituents of the soil existing in a condition not so easily assimilated.

The accompanying tables exhibit the results of the mechanical and chemical analysis of the several samples of the soil investigated.

I submit two reports of the chemical analysis, one calculated on the basis of the air dry soil, as taken from the field; the other on the same dried at 100 degrees Centigrade.

Respectfully submitted,
(Signed) A. B. Lyons,
*Analytical Chemist.*

### Result of Mechanical Analysis.

A.—Percentage proportion of the air dry soil retained by a sieve having circular apertures 0.5 mm. in diameter.

| | No. 1. | No. 2. | No. 4. | No. 6. |
|---|---|---|---|---|
| "Fine Soil."—Passes a ½ mm. sieve | 99.54 | 98.21 | 97.45 | 99.11 |
| Retained by a ½ mm. sieve | 0.46 | 1.79 | 2.55 | 0.89 |
| Total (air dry) | 100.00 | 100.00 | 100.00 | 100.00 |

B.—Percentage of the "fine" soil (above), after drying at 100 deg. C. of the grades designated, as separated by silt analysis. (Osborne's Method.)

| | No. 1. | No. 2. | No. 4. | No. 6. |
|---|---|---|---|---|
| Particles 0.5 to 0.2 mm. diameter | 0.86 | 1.01 | 0.67 | |
| "Sand" 0.2 to 0.05 mm. | 2.62 | 10.01 | 5.39 | |
| "Silt" 0.05 to 0.01 mm. | 7.35 | 16.39 | 16.52 | |
| Finest silt—about 0.008 mm. | 20.43 | 27.04 | 17.12 | |
| Dust, less than 0.008 mm. | 25.79 | 24.88 | 28.33 | 55.47 |
| Clay particles not measurable | 26.89 | 5.50 | 15.97 | |
| Organic matter and combined water | 16.06 | 15.17 | 15.00 | 13.55 |
| Total (Dried at 100 deg. C.) | 100.00 | 100.00 | 100.00 | 100.00 |

The locations of the soils in the above analysis are indicated on Map No. 2, thus, No. 1, No. 2, &c.

### Result of Chemical Analysis of Soils from Ewa (Air-Dried).

Solution made by boiling two hours with Hcl.

| | No. 1. | No. 2. | No. 4. | No. 6. |
|---|---|---|---|---|
| Moisture (Dried at 140 deg. C.) | 11.300 | 13.990 | 9.874 | 13.870 |
| Organic matter and combined water | 14.250 | 13.050 | 13.520 | |
| Residue insoluble in Hcl | 36.159 | 36.334 | 32.654 | 30.609 |
| Silica, etc. | 1.071 | .926 | 2.451 | |
| Ferric Oxide, $Fe_2O_3$ | 15.120 | 11.920 | 18.400 | |
| Alumina, $Al_2O_3$ | 20.457 | 22.080 | 22.294 | |
| Lime, Cao. | .288 | .338 | .239 | .270 |
| Magnesia, Mg O | .172 | .234 | .251 | |
| Potash, $K_2O$ | .377 | .432 | .256 | .307 |
| Soda, $Na_2O$ | .254 | .227 | .236 | |
| Manganese Oxide, M N O | .108 | .134 | .084 | |
| Phosphoric Acid, $P_2O_5$ | .143 | .120 | .186 | .108 |
| Sulphuric Acid, $SO_3$ | .055 | .023 | .039 | |
| Copper Oxide, Cu O | Trace | .020 | Trace | |
| Total (actual weight) | 99.754 | 99.828 | 100.484 | |
| | Per cent. | Per cent. | Per cent. | Per cent. |
| Nitrogen (Kjeldahl method) | 0.265 | 0.213 | 0.146 | 0.195 |

### Result of Chemical Analysis of Samples of Soil from Ewa.

(Soils dried at 100 deg. C.)

| | No. 1. | No. 2. | No. 4. | No. 6. |
|---|---|---|---|---|
| Organic matter and combined water | 16.06 | 15.18 | 15.00 | |
| Insoluble in Hydrochloric acid (boiled two hours) | 40.77 | 42.25 | 36.23 | 35.54 |
| *Silica, etc. | 1.21 | 1.08 | 2.72 | |
| †Ferric Oxide, $Fe_2O_3$ | 17.05 | 13.86 | 20.41 | |
| Alumina, $Al_2O_3$ | 23.06 | 25.68 | 24.73 | |
| Lime Ca O | 0.33 | 0.39 | 0.27 | 0.31 |
| Magnesia, Mg O | 0.19 | 0.27 | 0.28 | |
| Rotash, $K_2O$ | 0.43 | 0.50 | 0.28 | 0.36 |
| Soda, $Na_2O$ | 0.29 | 0.26 | 0.26 | |
| Manganese Oxide, M N O | 0.12 | 0.16 | 0.09 | |
| ‡Phosphoric Acid, $P_2O_5$ | 0.16 | 0.14 | 0.21 | 0.13 |
| Sulphuric Acid, $SO_3$ | 0.06 | 0.03 | 0.04 | |
| Copper Oxide, Cu O | Trace | 0.02 | Trace | |
| Total (actual weight) | 99.73 | 99.82 | 100.52 | |
| | Per cent. | Per cent. | Per cent. | Per cent. |
| Nitrogen (Kjeldahl method) | 0.299 | 0.248 | 0.162 | 0.225 |

* The silica rendered insoluble by drying in the usual manner, in these volcanic soils, carries with it titanic acid, iron and some phosphoric acid.

† In samples 1, 2 and 6 the iron is probably all in the form of $Fe_2O_3$. In No. 4 a portion of it is probably ferrous, which will account for the excess in the sum total of the constituents over 100 per cent.

‡ The total phosphoric acid dissolved from the soil by nitric acid.

## LETTER FROM SERENO E. BISHOP.

Honolulu, December 5th, 1894.

Mr. B. F. Dillingham,
*General Manager O. R. & L. Co.*
Honolulu.

Dear Sir:—As to the character of the 10,000 acres of land which it is proposed to use for the new sugar plantation, I can heartily testify that being quite familiar with the tract, I consider the soil to belong to the best class of cane land. As stated in your prospectus, it is perfectly clear and smooth, ready for the ploughs.

I have often regarded this land as most promising to become the future home of agriculturists who should raise crops from the copious rains of the winter season. The tract averages probably thirty inches of rain per annum, leaving two-thirds to be supplied by irrigation This must be twice the rain enjoyed by Ewa Plantation. Hence cost of pumping to the same height would be one-fifth less than at the latter place.

Your accessible water supply from springs at sea level alone is ample for 6000 acres. Besides this, as much more could probably be drawn from artesian wells flowing thirty or more feet above sea level. Could this enormous water supply be united to the splendid lands adjacent, the result would be a magnificent development of values. I am not competent to express any judgment as to the feasibility of lifting this water to the upper levels proposed. Actual experience of the cost of pumping at Ewa Plantation appear very strongly to favor your plans.

I believe that a very large addition of inexpensive water supply for the higher levels, saving much of the pumping, may be effected by saving and storing water in the upper gulches for use during the six rainy months.

Truly yours,
Sereno E. Bishop.

## LETTER FROM W. D. ALEXANDER.

Honolulu, December 1st, 1894.

Mr. B. F. Dillingham,
*General Manager O. R. & L. Co.*
Honolulu.

Dear Sir:—I do not think I can add anything new to the information which you already possess in regard to the site of the projected new plantation in the Ewa district.

The ground is quite familiar to me, as I assisted in the original survey of Pearl Lochs in 1873, and afterwards surveyed Honouliuli and part of Waikele.

The land in question slopes gently towards the sea, being divided into nearly equal portions by the Waikele ravine, which widens out above the Government road, forming a broad level site well adapted for a central mill.

The quality of the soil to all appearance is identical with that of the Ewa plantation, and this opinion is confirmed by the chemical analyses of it which have been made. Between Hoaeae and Waiawa there is land enough for a first-class plantation, even below the line of the 400 ft. level.

In regard to the available water supply, the magnificent Waipahu spring, which has not varied perceptibly during the last twenty years, would almost render its owners independent of any other source. According to the measurements made by your engineers it pours out water enough to irrigate 3000 acres.

The Ewa artesian water reservoir is evidently distinct from that of the Honolulu district, as the water in its limits stands at a lower elevation than it does in the Honolulu wells. It is most likely that Moanalua valley and its craters form the boundary separating the two basins. It is certain that the wells in the Honolulu district do not affect the water supply of the Ewa district.

To conclude, the land and water supply are ample and can be depended upon. The cost of pumping and the supply of efficient and reliable laborers are questions which lie outside of my province, and which you are fully able to meet and dispose of.

I remain, yours truly,
W. D. Alexander.